(12) **EUROPEAN PATENT APPLICATION**

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(54) **Improvements to control system for network servers**

(57) A data transfer network is provided which comprises a TFTP server connected to transfer data to a series of client apparatus connected to the network. When data is to be transferred, one of the clients is designated the master client and the speed of requests for data from the master client determines the rate of transfer of the data to all of the clients. The rate of transfer of data to each client, when elected as the master client, is monitored and compared with predetermined transfer rates. If from the comparison it is identified that the transfer rates is longer than that which is required, the TFTP server elects another client which is available as master client. In the event that one of the clients is disabled and cannot act as a master client to receive data, this is identified by the TFTP server by monitoring network management messages which identify the disablement or unavailability of the client. If a client is identified as being unavailable or disabled, the TFTP server does not attempt to elect the client as master client.

EP 1 134 950 A2

Description

[0001] The invention to which this application relates is to improvements in the operation of a server known as a multicast Trivial File Transfer Protocol (TFTP) server which is provided in connection with a network of client apparatus. The server is provided to transmit and transfer data to the client apparatus.

[0002] The use of TFTP servers is relatively well known and one area in which the same is used is to provide information to a communications network which includes a number of client apparatus in the form of broadcast data receivers. This form of apparatus is provided in premises in increasing numbers and includes a means for receiving digital data which has been transmitted from a remote location such as by a television broadcaster and carried via any of cable, satellite or terrestrial transmission systems. When received the broadcast data receivers, decode the data and process the same to allow the generation of video, audio and/or text data for display, typically via a television set. The broadcast data receiving apparatus can be connected to the television set or may be provided as an integral part of the same. Each of the broadcast data receiver is provided with further communication means which allow the transfer of data to and from the same, and are provided as part of a networking communication with the TFTP server which can provide updated images or information data at intervals to all of the receivers on the network

[0003] There are however known problems with this type of system as follows. One problem is that when multiple receivers, hereinafter referred to as clients, are required to receive the data from TFTP server, one of the clients is identified as the master client by the server. The rate of data transfer is then controlled by the speed at which the master client requests, receives and acknowledges receipt of the data and the other clients in the network will then receive the data in accordance with the transfer rate between the master client and the server. This means that if the master client is slow in requesting the data, for whatever reason, then the other clients will also be adversely affected by the decreased transfer rate

[0004] A further problem is that if a client apparatus which is part of the network is rendered inactive and then restarted such as, for example, if the client is rebooted, interrupted or crashes, during the transfer of data from the TFTP server and it is not the master client, there is a possibility that there will be a period of time during which the server will attempt to inform the said client that it is now the master client. Although the server may have a predesignated time out period after which it will cease to attempt to make the client the master client, there is inevitably a delay during which none of the clients involved in the transfer of data can progress.

[0005] The aims of the present invention are to provide improvements to the TFTP network and the oper-

ation of the same which allow for the more efficient and faster transfer of data where possible and also attempt to avoid unnecessary delays in the transfer of data.

[0006] In a first aspect of the invention there is provided a data transfer network comprising a TFTP server connected to transfer data to a series of client apparatus connected to the network and when data is to be transferred, one of the clients is designated the master client and the speed of requests for data from said master client determines the rate of transfer of the data to all of the clients and when the rate of transfer of data to each client when elected the master client, is monitored and compared with a predetermined data transfer rate and if from the comparison it is identified that the transfer rate is longer than the predetermined transfer rate, the TFTP server elects another client which is available as master client.

[0007] By electing the client as master client which has shown the fastest rate of transfer so the server can ensure that the data which flows to all of the clients in the network will do so at the fastest possible rate.

[0008] In one embodiment the predetermined transfer rate is preset as an optimal time for the transfer of a certain amount of data and the master client is monitored for a set period of time.

[0009] In an alternative embodiment the transfer rate for each of the clients, when elected as master client, is recorded over a period of time and a database constructed of the transfer rates for each client and from which database the server will attempt on each occasion to elect as master client that client which shows the fastest transfer rate and in ascending order until an available client is found. Typically this database can be updated on each occasion when a client is selected as master client.

[0010] In a further aspect of the invention there is provided a data transfer network comprising a TFTP server connected to transfer data to a series of client apparatus connected to the network and when data is to be transferred one of the clients is designated as the master client and the speed of requests for data from said master client determines the rate of transfer of the data to all of the clients and wherein if one or more of the clients is disabled and cannot act as a master client to receive data this is identified by the TFTP server by monitoring network management messages which identify the disablement or unavailability of the client and whereupon the TFTP server does not attempt to elect the said client as master client.

[0011] In one embodiment the network includes a series of clients in the form of or including Internet Control Message Protocol (ICMP) servers and monitors the operation of the same to identify those client which are unavailable or disabled and, until it identifies that the said client is live once more, will not attempt to elect that client as the master client.

[0012] Thus, by monitoring the low level network management messages on the network so an attempt to

elect disabled clients as master clients can be avoided and the hence the same is prevented from causing a delay during which the data transfer is prevented from making progress.

[0013] Specific embodiments of the invention will now be described with reference to the accompanying diagram Figure 1 which illustrates in schematic fashion an embodiment of server and client network to which this invention relates. Although referred to hereonin as "clients" the invention has particular uses with respect to a network comprising a server which allows the transmission of data for updating, changing or otherwise amending the operation of a series of clients in the form of broadcast data receivers connected to a network and hence in turn to the server. Typically each broadcast data receiver is located in a different premises of a subscriber to a television system and the server is controlled and operated by the service provider and the data is transferred via a communications link to which each of the broadcast data receivers is connected.

[0014] In the first embodiment, the TFTP server protocol (RFC1350, RFC2090) used for the system is a lock step protocol. The data which is transmitted by the server is transmitted at a rate which is as fast as the client which has been elected master client acknowledges receipt of data and then requests the transfer of the next block or packets of data. The master client needs to process incoming data blocks and send its request for the next block as fast as possible in order to sustain a high data transfer rate. The rest of the clients act as slaves, simply accepting data transmitted via the network as it arrives, without the need to request further data. Thus if the master client is slow in any part of the data transfer procedure, or the network is losing packets and the server is required to retransmit data blocks, then all of the other clients suffer from the slowing down of the transfer too.

[0015] In accordance with the invention, if the server monitors the data transfer rate over a reasonable sample period such as 5 seconds and determines, either through configuration or knowledge of the network topology, that the rate is less than a predetermined data transfer rate, it deposes the master client and elects a new client as master client.

[0016] Thus, the newly elected master client is then checked against the predetermined data transfer rate and if it is acceptable and hence able to receive and respond to the data packets in a faster manner, the data transfer rate is quicker to all of the clients in the network.

[0017] It may also be the case that the previous master client which was too slow is now capable of receiving the data at the same speed as the other clients as the previous problems of lack of speed was caused by its inability to transmit the acknowledgements quickly enough and/or request new data quickly enough. As it no longer needs to do this as it is no longer the master client so the actual receipt of the data can be at the increased speed.

[0018] A specific example is now provided with reference to the accompanying diagram. A TFTP server s1 is connected to a network of clients r1-r10, such as broadcast data receivers, each receiver located in a different premises and connected to the server which is located at a remote location, via a communications link, such as a telecommunications link.

[0019] The server s1 is configured to select one of the clients as a master client with the master client communicating with the server to acknowledge the receipt of data and request the next portion of data. The remainder of the clients then act as slaves to the master client, receiving the data at the speed set by the transfer rate between the master client and the server.

[0020] The server is set to check the data transfer rate with the master client at certain time periods, say 5 seconds, and compare the actual data transfer rate with a required predetermined rate of 50 kilobytes per second.

[0021] In accordance with this embodiment, the ten broadcast data receivers r1-r10 download data for an Operating System (OS) image over the network concurrently, by using the multicast TFTP server. In practice the Client r1 supports a slower data transfer rate machine than clients r2-r10. However initially the server elects client r1 as the master client and upon commencement a data transfer rate of only 40 kilobytes per second is being achieved. After 5 seconds the server checks the data transfer rate, compares the same with the predetermined transfer rate of 50 kilobytes per second and determines that client r1 is too slow. It then stops r1 from continuing as the master client and elects client r2 in preference. Client r2 can sustain a data rate of 60 kilobytes per second which exceeds the predetermined data transfer rate and so r2 continues as the master client and thereafter all the other clients continue to receive data at the faster rate, and which may include client r1.

[0022] In one embodiment the server can be provided with a memory wherein if a client which is elected as a master client cannot meet the predetermined data transfer rate, either for the first time or after a number of attempts, the identity if that client is held in memory and thereafter the server does not attempt to elect that client as a master client until it is removed from the memory, if for example, the same is fixed. Furthermore if a certain proportion of clients identities are found to be held in the memory over time, this will indicate that the network may fail as there are no longer sufficient clients available to meet the criteria of the predetermined data transfer rate and so repair work may be required on the network.

[0023] In a further embodiment the transfer rate for each of the clients, when elected as master client, is recorded and stored in the server memory and, when the need to elect a master client arises, the server attempt to elect as master client the client which has a transfer rate, in accordance with the data held in the memory, which has the fastest rate of transfer. Typically, if the first client which the server attempts to use as master client

is not available, the server attempts to elect a further client from the database and so on in ascending order in terms of the client data transfer rates. Typically when a client has been elected, the data transfer rate for the selected client is entered on the database. In one embodiment the data transfer rate which is used can be the last transfer rate or alternatively an average transfer rate can be used.

[0024]   An example of a further improvement of the invention is now described. In this example, the TFTP server s1 is transmitting a TFTP datagram to a specific client (e.g. to inform it has been selected as master client). If the TFTP software for that client is no longer running then the network software on the client will send back an ICMP Port Unreachable message to the server.

[0025]   However usually the network memory on the server does not know to which socket the message should be delivered and so the server software is unaware that the error has occurred.

[0026]   However in accordance with the invention, the server monitors the ICMP messages received from the clients and processes the same so as to identify that the TFTP software of a client has failed and that there is no point in continuing to try and elect that client as master client. Thus the server will ignore that client and elect another client without undue delay to the data transfer. This can continue until a message is received from the client to indicate that it has been fixed and is then operable again.

[0027]   A specific example of this' is now described with reference to the accompanying diagram with the 10 broadcast data receivers r1-r10 connected to the TFTP server s1. In this case r2 has been elected as the master client. However during data transfer the TFTP client r3 falls below client r2 has completed the data transfer.

[0028]   Once client r2 has completed the transfer, the TFTP server detects that r3 has not received the data and tries to elect client r3 as master client however the server receives an ICMP port unreachable message for client r3. Thus when the next need to elect a master client arises, the server ignores r3 and immediately moves on to elect client r4. Conventionally the server would have delayed for a number of seconds as it waited to give client r3 a chance to respond thus holding up the transfer of data for all the other clients.

[0029]   Thus the present invention provides a system for the control the network which improves the data transfer rate throughout the network and overcomes unnecessary delays.

Claims

1. A data transfer network comprising a TFTP server connected to transfer data to a series of client apparatus connected to the network and when data is to be transferred, one of the clients is designated the master client and the speed of requests for data from said master client determines the rate of transfer of the data to all of the clients **characterised in that** the rate of transfer of data to each client when elected the master client is monitored and compared with a predetermined transfer rate and if, from the comparison, it is identified that the transfer rate is longer than the predetermined data transfer rate, the TFTP server elects another client which is available, as master client.

2. A data transfer network according to claim 1 **characterised in that** the TFTP server elects a client as master client which has shown the fastest rate of transfer from the series of clients.

3. A data transfer network according to claim 1 **characterised in that** the predetermined transfer rate is preset as an optimal time for the transfer of a certain amount of data.

4. A data transfer network according to claim 1 **characterised in that** the master client is monitored for a set period of time to allow comparison with the pre-determined transfer rate.

5. A data transfer network according to claim 1 **characterised in that** the transfer rate for each of the clients, when elected as master client, is recorded over a period of time and stored in a database of transfer rates, the server using the database so that on each occasion the server elects as master client the client which shows the fastest rate of transfer in the database.

6. A data transfer network according to claim 5 **characterised in that** if the first client which the server attempts to use as master client is not available, the server attempts to elect a client from the database based on an ascending order of client transfer rates.

7. A data transfer network according to claim 5 **characterised in that** the database is updated on each occasion when a client is selected as master client.

8. A data transfer network comprising a TFTP server connected to transfer data to a series of client apparatus connected to the network and when data is to be transferred, one of the clients is designated as the master client and the speed of requests for data from said master client determines the rate of transfer of the data to all of the clients **characterised in that** if one or more clients is disabled and cannot act as a master client to receive data, this is identified by the TFTP server by monitoring network management messages which identify the disablement or unavailability of the client and whereupon the TFTP server does not attempt to elect the said client as master client.

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9. A data transfer network according to claim 8 **characterised in that** the network includes ICMP servers and monitors the operation of the said servers to identify those clients which are unavailable or disabled, and until it identifies that the said client is live once more, will not attempt to elect that client as the master client.
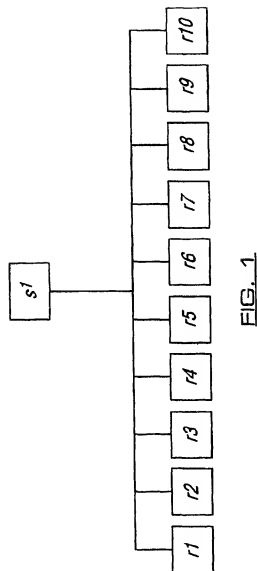
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FIG. 1

(54) Improvements to control system for network servers

(57) A data transfer network is provided which comprises a TFTP server connected to transfer data to a series of client apparatus connected to the network. When data is to be transferred, one of the clients is designated the master client and the speed of requests for data from the master client determines the rate of transfer of data to each client, when elected as the master client, is monitored and compared with predetermined transfer rates. If from the comparison it is identified that the transfer rates is longer than that which is required, the TFTP server elects another client which is available as master client. In the event that one of the clients is disabled and cannot act as a master client to receive data, this is identified by the TFTP server by monitoring network management messages which identify the disablement or unavailability of the client. If a client is identified as being unavailable or disabled, the TFTP server does not attempt to elect the client as master client.

EP 1 134 950 A3

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EUROPEAN SEARCH REPORT

Application Number

EP 01 30 2295

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y	EMBERSON A: "RFC 2090; TFTP Multicast Option" IETF - INTERNET ENGINEERING TASK FORCE, February 1997 (1997-02), XP002249823 Passage until "... single multicast address" * page 3, paragraph 1 - page 4, paragraph 2 * -----	1-7	H04L29/06 H04L29/08 H04L12/56 H04L12/18
Y	NARAYAN A P: "Reliable transfer of data in a local area network with multicast distribution" LOCAL COMPUTER NETWORKS, 1990. PROCEEDINGS., 15TH CONFERENCE ON MINNEAPOLIS, MN, USA 30 SEPT.-3 OCT. 1990, LOS ALAMITOS, CA, USA,IEEE COMPUT. SOC, US, 30 September 1990 (1990-09-30), pages 310-319, XP010022012 ISBN: 0-8186-2109-5 Complete passage "2 Description" not including 2.1 * page 311, left-hand column - page 312, left-hand column * Passage "2.4 Dynamic Assignment of the Designated Acknowledger" * page 314 * ----- -/--	1-7	TECHNICAL FIELDS SEARCHED (Int.Cl.7) H04L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	4 August 2003	Raible, M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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EUROPEAN SEARCH REPORT

Application Number

EP 01 30 2295

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	DELUCIA D ET AL: "Multicast feedback suppression using representatives" INFOCOM '97. SIXTEENTH ANNUAL JOINT CONFERENCE OF THE IEEE COMPUTER AND COMMUNICATIONS SOCIETIES. DRIVING THE INFORMATION REVOLUTION., PROCEEDINGS IEEE KOBE, JAPAN 7-11 APRIL 1997, LOS ALAMITOS, CA, USA,IEEE COMPUT. SOC, US, 7 April 1997 (1997-04-07), pages 463-470, XP010252039 ISBN: 0-8186-7780-5 Complete Chapter 1 "Introduction" * page 463 * Paragraphs starting with "Feedback Suppression Algorithm" until "Timers" * page 464, right-hand column - page 465, right-hand column * -----	1-7	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
Munich	4 August 2003	Raible, M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-7

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LACK OF UNITY OF INVENTION
SHEET B

The Search Division considers that the present European patent application does not comply with the
requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-7

    A system for election of master clients based on a
    supervision of the transfer rate.
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2. claims: 8-9

    A system for detecting a master client which has failed
    using network management messages.